



The Implementation of Geospatial Web Services at GeoBrain

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Introduction

- The NASA EOS Higher Education Alliance (NEHEA) project is one of projects funded by NASA REASoN program.
 - To mobilize NASA EOS data and information through Web service and knowledge management technologies for higher-education teaching and research.
- The GeoBrain system
 - A standard-compliant, open, distributed, three-tier, web service based information system to enable the goal of NEHEA.
 - The system will make peta-bytes of NASA EOS data and information in both on-line data pools and near-line storages, easily accessible to higher-education users as if they have such resources locally.



The NASA EOS Higher Education Alliance

- led by GMU and consists of the development team and educational partners
- The development team
 - George Mason University
 - Northern Illinois University
 - University of Texas at Dallas
 - City University of New York-Lehman College
 - Responsible for the development, maintenance, and operation of GeoBrain.
- Education partners
 - Funded Earth science educators from nine universities
 - Non-funded educational partners
 - Responsible for promoting the use of the system in teaching and research of Earth system science (ESS) at higher-education institutes.



The Development of GeoBrain Services

- GeoBrain is a web-services based geospatial knowledge system for providing value-added geospatial service and modeling capabilities to ESSE user community.
- The development of GeoBrain is the core of the technology development in the NEHEA project.
- During the past year, significant progresses have been made on developing and deploying GeoBrain
 - Several geospatial web services
 - A workflow execution engine (BPELPower)
 - The enhancement of Multiple Protocol Geoinformation Client (MPGC).

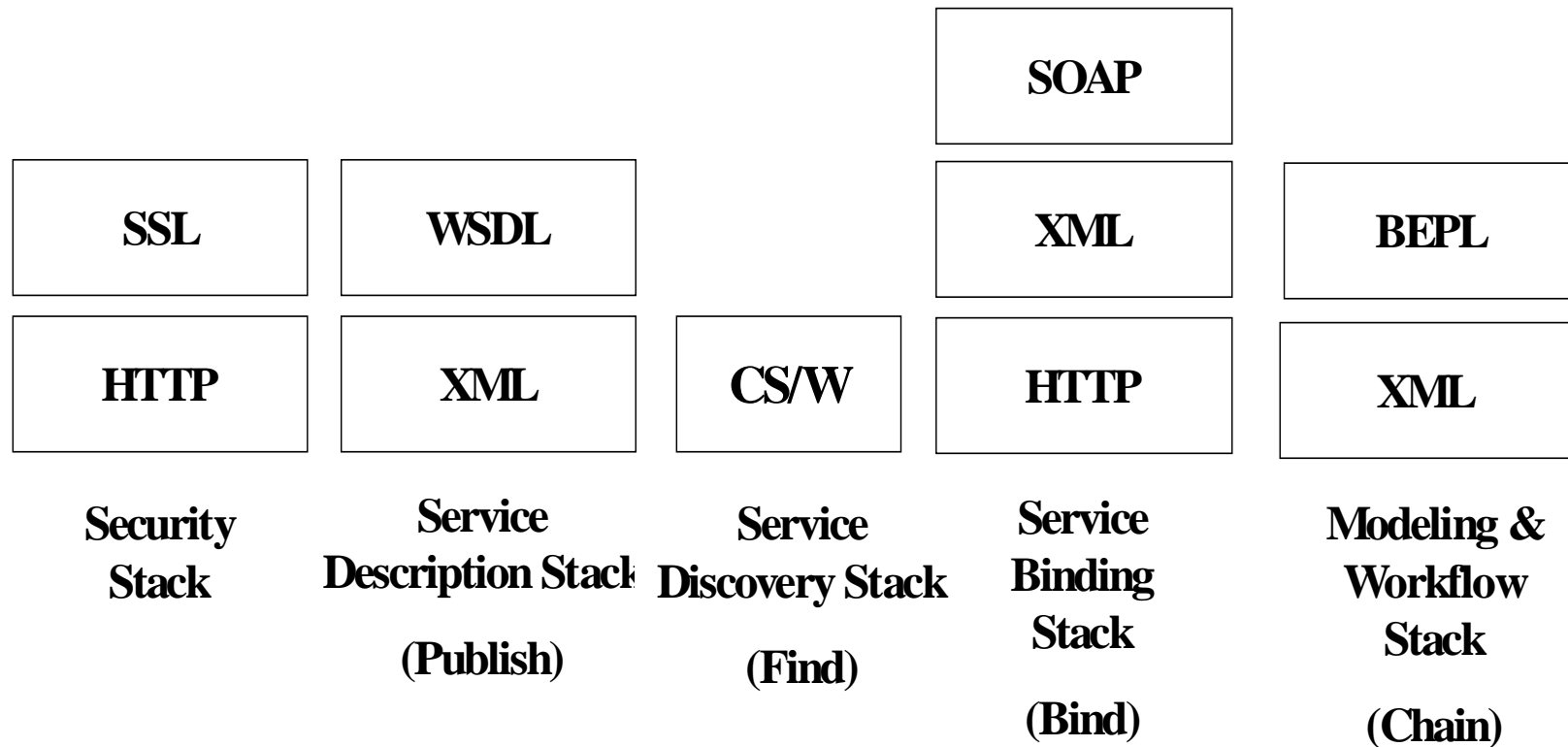


GeoBrain's Geospatial Web Services

- Individual geospatial web services are the building blocks for constructing a geospatial processing workflow.
- The power of GeoBrain relies on the availability of large numbers of standard compliant, chainable services.
- This project has spent a fair amount of time and resources to develop individual geospatial web services.
 - All GeoBrain services follow the OGC and W3C service standards.
 - All services are chainable.
- The URLs for those services can be found at <http://geobrain.laits.gmu.edu>.



Web Service Standards Used in GeoBrain





GeoBrain Web Coverage Service (WCS)

- OGC WCS supports the networked access to multi-dimensional and multi-temporal geospatial data in HDF-EOS as "coverage"
- WCS provides intact geospatial data products encoded in HDF-EOS, NITF, GeoTIFF, and netCDF (soon) to meet the requirements of client-side rendering, multi-source integration and analysis, and inputs to scientific models and other clients beyond simple viewers.
- Compliant with WCS specification 1.0. and 1.0.2
- WSDL description and SOAP binding were added to both versions of the servers so that they become chainable services.
- Both versions of services can work with all NASA EOS datasets in standard HDF-EOS format.
- Currently working on extensions to support access to data in more than 30 formats by using the GDAL library.



GeoBrain Web Map Service

- OGC WMS supports the networked interchange of geospatial data as "map" which is generally rendered in a spatially referenced pictorial image, such as PNG, GIF or JPEG, dynamically from real geographical data.
- NWGISS contains a WMS 1.1.1 server that works with NASA HDF-EOS data.
- Similar to NWGISS WCS server, the server is enhanced to become a chainable service.
- The service has been deployed at an Apple cluster server as a part of GeoBrain Map services



Web Coordinate Transformation Service (WCTS)

- An OGC WCTS service has been developed for re-projecting a coverage encoded in HDF-EOS Grid from one map projection to another one.
- The service is based on the OGC WCTS draft specification.
- Currently the service supports all of the map projections defined in GCTP and used in HDF-EOS.
- The required input parameters for using the service include the URL of source HDF file, target projection type, resampling method, bounding box and the 15 float-type projection parameters defined by GCTP, and the result is a URL point to the resulted HDF file



Web Image Classification Service (WICS)

- An unsupervised image classification service was developed by using a clustering algorithm.
- The service takes two parameters:
"initialNumberOfClusters" and *"imageURL"*.
 - All other parameters are set to default values to make the input simpler.
- The return of this service is "classifiedImageURL" point to classified image.
- The service is deployed at <http://data.laits.gmu.edu:8099/wics/classifiers/>.
- The service was a part of the development of OGC Web Service Initiative 2.0 and resulted in an OGC discussion paper on Web Image Classification Service.



Web Image Cutting Service (IMCS)

- IMCS allows user to get data for an area specified by a state name or a series of coordinates that defines a polygon.
 - Not like the bounding box that only allows for a rectangular region, the cutting service will cut out the image in any shape specified by the set of coordinates.
 - A filling value is given for the area outside of the polygon. The filling value (normally zero) is recorded in metadata.
- The service can be easily chained with other services, such as WCS to provide access to data for a specific non-rectangular administrative or geographic region



GRASS Web Services

- The power of GeoBrain relies on having a large number of interoperable, web-based geospatial processing services.
- It is very time consuming to develop such services from scratch and the project cannot afford to develop services in this way.
- Our strategy is to make existing geospatial processing packages web-service enabled.
- The software package we chose is an open source GIS package called GRASS.
 - add SOAP-based web service interfaces and provide WSDL descriptions to more than 200 geospatial processing modules in GRASS.
- A detailed description of the GRASS Web services can be found at the web page:

http://geobrain.laits.gmu.edu:8099/webservices/grass/Grass_Web_services.html



Catalog Service for Web (CSW)

- OGC CSW specification supports the registry and discovery of geospatial information resources.
 - Plays a “directory” role in the open, distributed Web service environment.
 - Data and services providers register their capabilities using metadata, and users can then query the metadata to discover interesting information.
- A catalog service has been developed
 - implements OGC Registry Information model (OGC-RIM)
 - allows users to discover distributed service and data by a very simple user interface.
- The detailed descriptions, samples and usages of CSW server can be found at <http://geobrain.laits.gmu.edu/CSW/discovery/>
- A CSW portal is developed that provides OGC CSW interfaces at the frontend and searches multiple CSW servers as well as NASA ECHO at the backend.



GeoBrain Client Development

- Enhancement to Multi-Protocol Geoinformation Client (MPGC)
 - To make it more reliable and to work with services available at GeoBrain.
 - The overall goal of the enhancement is to make MPGC a GeoBrain services and modeling client.
 - MPGC complies with the OGC Catalog Service for Web (CSW) specification, allowing the registry, discovery and access of geospatial information resources that are distributed over Internet.
 - MPGC 1.0 also implemented the latest protocols of the OGC Web Feature Service (WFS), Web Map Service (WMS) and Web Coverage Service (WCS) to provides a single point of entry for accessing to OGC-compliant data and services
 - MPGC also can access Web geospatial processing services to generate value-added data products on demand. The URL for downloading MPGC: <http://geobrain.laits.gmu.edu/mpgc>
- GeoBrain Web Client
 - Provide access to data services and virtual geospatial data at GeoBrain without installing any software.



The Workflow Engine: BPELPower

- How all those services work together
 - MPGC allows users to construct a workflow by chaining services available from GeoBrain and other web services systems together.
 - Once a workflow is constructed, it is then executed by a workflow execution manager to produce the on-demand product.
- The GeoBrain development team has developed a workflow execution manager called BPELPower.
 - Based on the mainstream standards of Web services, including BPEL, WSDL, WSIF, Xalan, Xerces, UDDI, AXIS, SOAP, JNDI, J2EE (servlets/EJBs/JSPs), Jetspeed (Portlets) and JMX.
 - Runs on top of popular application servers, such as Tomcat, J2EE, JBoss, Weblogic and WebSphere.
 - Supports BPEL-based web service chain completely.
- BPELPower was demonstrated at OGC OWS 2.0 demo event in September 2004 to show the generation of virtual geospatial products on demand and the power of service chaining.
- <http://bpel.laits.gmu.edu>.



Deployment of GeoBrain at an Apple Cluster Server

- *Hardware*
 - Six Apple 64-bit Xserver with dual G5 processors.
 - Five Xserver RAID systems with total capacity of 21.7TB.
 - 2 Gbps Fiber Switch for exchanging data between cluster node and RAID system..
- *Software*
 - Installed components of the GeoBrain system, including the WCS, WMS, and CS/W servers.
 - GeoBrain services and BPELPower
- *Network*
 - 1 Gbps network link to Internet II
 - 100 Mbps network link to Internet I.



Data Available at GeoBrain

- Global Landsat
 - ETM (2000), TM (1990), and MSS (1975)
- Global DEM
- Sample EOSDIS data –MODIS, MISR, ASTER, EO-1 etc.
- NASA Data Pool data
 - Find users requested data in data pools through CWS portal to NASA ECHO.
 - Copy selected data pool data to the GeoBrain machine for value-added services.
- NASA EOS near-line data
 - Plan to develop machine to machine gateway.
- User statistics
 - Currently about 600 unique users/month using the GeoBrain services.



Conclusion and future work

- Web service technology is a very promising technology for solving problems related to geospatial interoperability and knowledge discovery.
 - The initial deployment and operation of GeoBrain have demonstrated this point and also shown the flexibility and extensibility of the service-oriental architecture (SOA) and standard-based geospatial web services.
 - The work on GRASS proves that it is not very difficult to turn the traditional, stand-alone geospatial analysis packages into chainable web services.
- We are very interested in the service interoperability by incorporating services from other services providers into our workflows, and by using GeoBrain services in other providers' workflow.
 - Currently there are very few services available.